## REMARKS

The above amendments are made in response to the Office action of January 21, 2011. Claims 1, and 3-11 are pending in the present Application. Claims 1, 6, and 9 have been amended, claims 2, 5, and 8 have been cancelled, and claim 10 has been withdrawn, leaving Claims 1, 3, 4, 6, 7, 9, and 11 for consideration upon entry of the present Amendment.

Support for the amendments to claim 1 can be found at least in claims 5 and 8 as originally filed, and in the specification as originally filed on p. 7, lines 11-12, which recites an adhesive layer, and on p. 8, lines 10-12, which recites heat treatment.

Reconsideration and allowance of the claims are respectfully requested in view of at least the above amendments and the following remarks.

### Claim Rejections Under 35 U.S.C. § 103(a)

Claims 1, 3, and 5-6 stand rejected under 35 U.S.C. § 103(a), as allegedly being unpatentable over Fujimoto et al. (U.S. Patent No. 7,410,728, hereinafter "Fujimoto") and further in view of Kawakami et al. (U.S. Patent No. 6,063,142, hereinafter "Kawakami"). The Examiner states that Fujimoto teaches a copper current collector comprising a microcrystalline or amorphous silicon thin film active material, states that the copper film is taught to have a surface roughness, and states that Fujimoto fails to teach that the morphology of the copper element is formed through an etchant process. Office action of January 21, 2011, p. 2. The Examiner also states that Kawakami teaches an anode surface having a roughened state through etching, and states that it would have been obvious to modify Fujimoto with Kawakami. Office action of January 21, 2011, pp. 2-3.

Also claims 4, 7-9, and 11 stand rejected under 35 U.S.C. § 103(a), as allegedly being unpatentable over Fujimoto and Kawakami and further in view of Zhang et al. (U.S. Patent Publication No. 2004/0018424, hereinafter "Zhang"). The Examiner states with respect to claim 8 that Zhang teaches a heating step of 300-350°C for one hour, and states that the properties of the heating step are inherent to the material and will therefore increase bond ability.

Applicants respectfully traverse these rejections for at least the following reasons and address them together.

The Applicants disclose a method for improving the charge/discharge characteristics of a lithium secondary battery by surface-treating a surface of an anode current collector to provide a selected surface morphology. Specification, p. 8, lines 2-3. The Applicants disclose vapor-depositing a silicon film on the surface-treated anode current collector to provide an anode active material by sputtering during application of a bias voltage. Specification, p. 8, lines 3-5. The Applicants also disclose disposing an adhesive layer between the surface-treated anode current collector and the silicon film and heat treating to improve bonding between the anode current collector and adhesive material. Specification, p. 8, lines 5-12.

More specifically, the Applicants disclose heat treating the anode current collector and the adhesive layer after formation of the adhesive layer on the anode current collector. The Applicants disclose that the heat treatment can induce a reaction at an interface between the anode current collector and the adhesive layer, providing improved bonding between the anode current collector and adhesive layer. Specification, p. 8, lines 12-16. A lithium secondary battery comprising the disclosed anode provides excellent charge/discharge cycle characteristics. See, for example, Fig. 14.

Amended independent claim 1 recites a method for improving charge/discharge cycle characteristics of a lithium secondary battery using a Si based anode active material, the method comprising:

surface-treating an anode current collector such that a surface morphology of the anode current collector has grain boundaries of 5 to 100 μm size throughout an entire surface of the anode current collector, and trenches having a depth of more than 1 μm formed at grain boundary junctions, wherein the surface-treating is performed by chemical or electrical etching using a wet method, or by reactive gas or ion etching using a dry method, to form a surface-treated anode current collector;

forming an adhesive layer on the surface-treated anode current collector;

vapor-depositing a silicon film on the adhesive layer to form an anode; and

heat-treating the anode, wherein the heat-treating increases a bond strength between the adhesive layer and the surface-treated anode current collector.

In making the rejection, the Examiner states with respect to claim 5 that "Fujimoto teaches use of an interlayer between the current collector and the active material as an

"adhesive layer.'" Office action of January 21, 2011, p. 3. The Examiner also states with respect to claim 8 that Zhang teaches "a heating step of 300-350°C for one hour." Office action of January 21, 2011, p. 4.

First, because the thin film battery of Zhang is distinct from that of Fujimoto and Kawakami, one of ordinary skill in the art would not have been prompted to consider Zhang, let alone modify Fujimoto in view of Kawakami and Zhang to arrive at that claimed by the Applicants.

Zhang discloses a thin film battery comprising a solid state LiPON electrolyte 15 on a polyimide supporting substrate 11. Zhang, p. 2, [0020], p. 3, [0024]. Thus the thin film battery disclosed in Fig. 3 of Zhang comprises a polyimide supporting substrate 11, a cathode current collector 13, a cathode 14, a lithiated transition metal oxide, the solid state electrolyte 15, an anode 16, and the anode current collector 17. These components are on the polyimide supporting substrate 11, as shown in Fig. 3 of Zhang.

Fig. 3 of Zhang

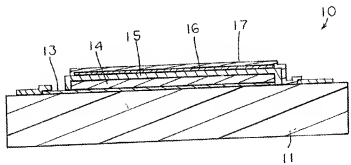


*FIG. 3*

In the Examples, Fujimoto teaches use of a liquid electrolyte. Fujimoto, col. 11, lines 4-7. Kawakami also teaches liquid electrolytes. Kawakami, col. 16, line 56 to col. 17, line 38. Because Fujimoto and Kawakami teach batteries using liquid electrolytes, one of ordinary skill in the art would not have considered modifying Fujimoto and Kawakami in view of Zhang, let alone have an expectation of success.

Second, in the heating step of Zhang cited by the Examiner, Zhang teaches that the $LiCoO_2$ films deposited on the polyimide substrate can be post-annealed at 300 to 350°C for

one hour "to enhance their crystalline structures." Zhang, p. 3, [0023]. Enhancing the crystalline structure of $LiCoO_2$ is distinct from and does not teach or suggest enhancing bonding between an anode current collector and an adhesive layer. Furthermore, Zhang does not disclose or suggest an adhesive layer, let alone an adhesive layer disposed between an anode current collector and an anode active material. Thus, for these reasons as well, one of ordinary skill in the art would not have been prompted to modify Fujimoto and Kawakami in view of Zhang to arrive at that claimed by the Applicants, let alone have an expectation of success.

Thus Fujimoto, Kawakami, and Zhang, either alone or in combination, do not teach or suggest a method for improving charge/discharge cycle characteristics of a lithium secondary battery using a Si based anode active material, the method comprising: surface-treating an anode current collector such that a surface morphology of the anode current collector has grain boundaries of 5 to 100 μm size throughout an entire surface of the anode current collector, and trenches having a depth of more than 1 μm formed at grain boundary junctions, wherein the surface-treating is performed by chemical or electrical etching using a wet method, or by reactive gas or ion etching using a dry method, to form a surface-treated anode current collector; forming an adhesive layer on the surface-treated anode current collector; vapor-depositing a silicon film on the adhesive layer to form an anode; and heat-treating the anode, wherein the heat-treating increases a bond strength between the adhesive layer and the surface-treated anode current collector, as recited in amended independent claim 1.

Thus, for at least these reasons, claim 1 is non-obvious and patentable over Fujimoto, Kawakami, and Zhang. Claims 3, 4, 6, 7, 9-11 depend from claim 1, and thus include the allowable elements of claim 1. Thus the dependent claims are patentable over the cited references for at least the reasons given above for independent claim 1.

Reconsideration, withdrawal of the rejection of claims 1, 3, and 5-6 under 35 U.S.C. § 103(a), and allowance of the instant claims are respectfully requested.

Claims 4 and 7 stand rejected under 35 U.S.C. § 103(a), as allegedly being unpatentable over Fujimoto and Kawakami and further in view of Tamura et al. (U.S. Patent Publication No. 2002/0034687, hereinafter "Tamura") as stated on p. 4 of the Office action of January 21, 2011. Applicants respectfully traverse for at least the following reasons.

It is respectfully noted that claims 4 and 7 depends from amended independent claim 1, which is allowable for defining over Fujimoto, Kawakami, and Zhang as discussed above. Furthermore, it is respectfully submitted that use of a bias voltage as allegedly disclosed in Tamura, or any other disclosure of Tamura, does not cure the deficiencies noted above with respect to Fujimoto, Kawakami, and Zhang.

Accordingly, it is respectfully requested that the rejection to claims 4 and 7 under 35 U.S.C. § 103 be withdrawn and the instant claims be allowed to issue.

Claim 11 stands rejected under 35 U.S.C. § 103(a), as allegedly being unpatentable over Fujimoto and Kawakami and Tamura and further in view of Zhang as stated on pp. 4-5 of the Office action of January 21, 2011. Applicants respectfully traverse for at least the following reasons.

It is respectfully noted that claim 11 depends from amended independent claim 1, which is allowable for defining over Fujimoto, Kawakami, and Zhang as discussed above. Furthermore, it is respectfully submitted that use of a bias voltage as allegedly disclosed in Tamura, or any other disclosure of Tamura, does not cure the deficiencies noted above with respect to Fujimoto, Kawakami, and Zhang.

Accordingly, it is respectfully requested that the rejection to claim 11 under 35 U.S.C. § 103 be withdrawn and the instant claims be allowed to issue.

**Conclusion**

It is believed that the foregoing amendments and remarks fully comply with the Office Action and that the claims herein should now be allowable to Applicants. Accordingly, reconsideration and withdrawal of the objection(s) and rejection(s) and allowance of the case are respectfully requested.

Applicants hereby petition for any necessary extension of time required under 37 C.F.R. 1.136(a) or 1.136(b) or any other necessary fees(s), which may be required for entry and consideration of the present Reply.

If there are any additional charges due with respect to this Amendment or otherwise, please charge them to Deposit Account No. 06-1130 maintained by Applicants' Attorneys.

Respectfully submitted,

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